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The greatest value y can have is found by putting $x = 0$ in (1), which gives $y = \frac{1}{2}a$. Hence the required probability is

$$p = \frac{\int_0^{\frac{1}{2}a} p'dy}{\int_0^{a} dy} = \frac{1}{a}\int_0^{\frac{1}{2}a}\left\{1 - \frac{1}{2\left(1 - \frac{y}{a}\right)}\right\}dy$$

$$= \frac{1}{a}\left[y + \tfrac{1}{2}a \log\left(1 - \frac{y}{a}\right)\right]_0^{\frac{1}{2}a}$$

$$= 1 - \tfrac{1}{2}(1 + \log 2).$$

[*Artemas Martin.*]

101

Express in terms of $\sin^{-1}x$ and $\sin^{-1}y$

$$\tan^{-1}\frac{x+y}{\sqrt{(1-x^2)} + \sqrt{(1-y^2)}}.$$

SOLUTION.

If $\sin^{-1}x = a$ and $\sin^{-1}y = b$, we have

$$\tan^{-1}\frac{x+y}{\sqrt{(1-x^2)} + \sqrt{(1-y^2)}} = \tan^{-1}\frac{\sin a + \sin b}{\cos a + \cos b}$$

$$= \tan^{-1}\tan\tfrac{1}{2}(a+b) = \tfrac{1}{2}(a+b) = \tfrac{1}{2}(\sin^{-1}x + \sin^{-1}y).$$

[*Cooper D. Schmitt.*]

* * *

EXERCISES.

111

A circle is inscribed in an isosceles triangle; another in the space between the first circle and the vertex, and so on *ad infinitum*. What is the vertical angle when the sum of the areas of the circles is $1/n$ of the area of the triangle?

[*L. G. Weld.*]

112

To inscribe in the given triangle ABC a triangle PQR whose sides QR, RP, PQ are perpendicular respectively to BC, CA, AB. [*Alfred C. Lane.*]

113

THE transversal MN meets the sides AB, AC of the fixed triangle ABC, and makes

$$AM\,.\,AN = BM\,.\,CN.$$

Find its envelope. [*O. Root, Jr.*]

114

A CIRCLE intersects a conic in four points, P_1, P_2, P_3, P_4. Show that if the x-axis be parallel to the axis of the conic the area of their quadrilateral is

$$(x_2 - x_4)(y_1 - y_3).$$

[*R. H. Graves.*]

115

IN an equilateral triangle inscribe a triangle similar to a given triangle and having a maximum area. [*W. M. Thornton.*]

116

FIND the value of $\int Q dx$ where

$$Q = \cos(a_1 x + b_1)\cos(a_2 x + b_2)\ldots\cos(a_n x + b_n),$$

$a_1, a_2, a_n, \ldots$ and $b_1, b_2, \ldots b_n$ being constants. [*A. Hall.*]

SELECTED.

117

SHOW that the angle between the tangent to the ellipse $b^2x^2 + a^2y^2 = a^2b^2$ and the tangent at the corresponding point of the principal circle is given by the formula,

$$\tan\delta = \frac{\alpha\tan\varphi}{(1-\alpha) + \tan^2\varphi},$$

where $\alpha = (a - b)/a$ is the ellipticity, and φ is the eccentric anomaly.

118

SHOW that the eccentric anomaly which gives the maximum deviation is $\tan^{-1}\sqrt{(1-\alpha)}$, and find the co-ordinates of the point of contact T and the equation to the tangent t.

119

SHOW that the portion of t intercepted between the axes equals in length the sum of the semi-axes a, b, and is divided at T into these two parts.

120

SHOW that the circumcircle of txy passes through the centre of curvature at T, and that the area of the circle of curvature equals that of the ellipse.

121

SHOW that when the ellipse varies subject to the condition, $a + b$ constant, the locus of T is the hypocycloid,

$$x^{\frac{2}{3}} + y^{\frac{2}{3}} = (a + b)^{\frac{2}{3}},$$

which touches each ellipse at the point T.